STATEMENT

OF THE

WURTZ AMALGAMATION COMPANY

OF NEW YORK.

Office, No. 57 Broadway, Room 21,

NEW YORK CITY.

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1866.

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OFFICERS

OF THE

WURTZ AMALGAMATION COMPANY.

President,
JACOB GOEDEL.

Secretary and Treasurer,
C. ELTON BUCK.

Superintendent,
PROF. HENRY WURTZ.

Trustees,
JACOB GOEDEL,
GEO. F. DUNNING,
COL. DANIEL W. TELLER,
ERNST BREDT,
JOHN ADAMS JOHNSON,
HENRY WURTZ,
C. ELTON BUCK.

Capital Stock, - - - - $500,000,

Divided into 50,000 Shares, at a par value of $10 each.

CARD.

THE WURTZ AMALGAMATION COMPANY is now prepared to offer to mining companies and individuals engaged in working mines of the precious metals the use of the process described in the following pages.

The terms and conditions upon which rights to use the process are obtainable, may be had on application at the office of the Company, No. 57 Broadway, New York.

JACOB GOEDEL, *President.*

C. ELTON BUCK, *Secretary.*

STATEMENT OF THE

WURTZ AMALGAMATION COMPANY.

THE Wurtz Amalgamation Company, duly organized under the general law of the State of New York, has become, by purchase from Professor Henry Wurtz, the owner of his patents for the application of sodium amalgam to the metallurgical treatment of gold and silver ores, as well as his numerous applications of the same invention to other metallurgical and industrial operations. After a long series of elaborate and thorough trials of Prof. Wurtz's process on auriferous ores of various kinds, the company is now prepared to offer its use to the mining community, convinced that it will effect a largely increased yield of precious metal, and that its adoption will put an end to the immense losses now experienced by reason of imperfect amalgamation.

It is unnecessary to dwell upon the fact that the present status of gold and silver metallurgy is lamentably deficient. The experience of California, Nevada, Colorado, Idaho, Montana, Arizona, and all our gold-bearing states and territories, proves that by the ordinary methods of amalgamation more gold is left in the tailings than is extracted from the ores. In Colorado, for example, the average amount of gold extracted from the pyritous ores is not much above twenty per cent of the entire amount contained therein, while in California, where quartz veins containing but few sulphurets abound, and many of them are being worked, the yield, though greater, is far less than it ought to be. Were a thorough process of amalgamation available, not only would the mines now being worked increase their yield in a very great ratio, but the success attending the operation of these would stimulate the opening of multitudes of new mines, and would thus add greatly to the production of bullion.

There is no longer room for doubt that Prof. Wurtz's process of amalgamation will prove the desideratum so long recognized. The investigation of its merits by the Company, during a period extending more than a year, and the trials which have been made on a working scale, have demonstrated its success, and led

to the most sanguine estimates of its importance. Annexed to this statement will be found documentary evidence of this success in the results of experiments therein detailed, together with the opinions of well known men of science, all of which confirm the expectations previously entertained of the process.

Some of the more important of the advantages attending the use of Prof. Wurtz's process of amalgamation may be briefly alluded to.

1st, A very largely increased yield of gold is assured, in some instances bringing it up to the entire quantity of the precious metal contained in an ore. This fact will be recognized by every practical gold miner as one of immense importance; and when it shall have been fully brought to the notice of those engaged in working gold mines, it must lead to the use of the process wherever the precious metals are found.

2d, Loss of quicksilver by "flouring" or granulation is entirely prevented by the use of this process. The addition of sodium amalgam to floured quicksilver will restore it instantly to its liquid condition. This assertion has been verified by every operation with the process.

3d, The adoption of this process does not involve any change in machinery or apparatus. The improvement being purely chemical, the same mechanical appliances may be used as when ordinary quicksilver is employed.

4th, The operation of amalgamation by Prof. Wurtz's process may be completed in less than one half the time ordinarily employed in running the pans. The use of this process therefore, by reducing the time to less than one half, practically more than doubles the capacity of the amalgamating machinery.

The largely increased yield of gold which is assured by the employment of sodium amalgam, without the other advantages attending its use, would alone suffice to prove the great value of the process. In the experiments which have been conducted with a view to ascertain this fact, on a large as well as on a small scale, the results have been extraordinary, the increased yield ranging (when the trials have been performed with ordinary care) from thirty to nearly one hundred per cent. The remarkable affinity for gold imparted to quicksilver by sodium amalgam may be readily shown by a small experiment in a watch glass. On pouring a few drops of quicksilver into the glass, and bringing into contact with it a fine pellet of native gold, it will be found that in a majority of instances there will be an absolute repulsion existing between the two metals, and that the gold, except where it may have been cut or scratched, will not be even enfilmed. If now a small fragment of sodium amalgam be added to the quicksilver, the gold will be instantly coated and in a few seconds will be completely penetrated by the mercury.

The same wonderful power of the sodium amalgam may be shown by a simple experiment upon copper plates. If a piece of sheet copper be placed in contact with ordinary quicksilver, even if it be rubbed with the latter metal, no enfilming or union will take place, but if a minute quantity of sodium amalgam be dissolved in the quicksilver, the copper will be instantly coated at every point of contact.

The peculiar action of sodium amalgam as shown in the small experiments above mentioned, is even far more efficacious when used on the large scale, in amalgamating machinery operated as is usual in gold and silver mills. This has been especially proved in the experiments conducted under the supervision of Prof. Silliman, as alluded to in his paper read before the National Academy of Sciences at the meeting held in Washington in January last. An abstract of this paper will be found annexed hereto. In this experiment the quantity of the ore operated upon was upwards of a quarter of a ton, while the amount of gold extracted by the use of the sodium amalgam was very nearly equal to the whole quantity existing in the ore as revealed by the fire assay.

In like manner the experiments made under the supervision of Dr. John Torrey, United States Assayer, upon ore from the celebrated "Moss Lode" of Arizona, show a very largely increased yield of gold by the use of Prof. Wurtz's process. In these experiments a small barrel amalgamator was employed, the ore being tried in two separate equal quantities, one with ordinary quicksilver, and the other with quicksilver in which a small quantity of magnetic amalgam had been dissolved. In the first experiment (with ordinary quicksilver) the amount of gold obtained was 45 per cent. of the quantity contained in the ore; while in the second experiment (with sodium amalgam) 78 per cent. of the content of gold was obtained, being an increased yield of 73 per cent.

It is well known that in the ordinary method of amalgamating gold and silver ores, whether in stamp battery or in arrastras or pans, a large loss of quicksilver occurs, by reason of the "flouring" or granulation of this metal, whereby it is cut up into fine particles which are lost in the tailings. These fine globules of mercury become coated with impurities and so lose their power of cohesion, and while in this condition it is almost impossible for them to be brought together again into one mass. The loss of quicksilver by "flouring," in the state of Nevada alone, has been computed by those conversant with the business of mining, at *one hundred tons per annum!* And yet this loss, great as it is, is but a fraction of the total amount of money wasted by the granulation of quicksilver. The floured quicksilver is that portion which is richest in precious metals, and

this, as a matter of course, is lost along with the mercury. The same authorities, just alluded to, estimate the loss of precious metals in Nevada, resulting from their being retained in the floured quicksilver, at *upwards of twenty millions of dollars per annum!* Startling as this statement may appear it is undoubtedly within the mark. In the operations which have been performed with Prof. Wurtz's process *no* loss whatever of quicksilver has ensued.

The rapidity with which floured quicksilver may be made to re-unite into one mass by the use of the sodium amalgam, may be shown in a very satisfactory manner by agitating a little mercury with solution of copperas in a test-tube. In a few moments the mercury will become converted into globules. If now a very small fragment of sodium amalgam be thrown in, the globules will almost instantly run together, and subsequent agitation will fail to flour the quicksilver again.

The fact that no change in amalgamating machinery is rendered necessary by the use of Prof. Wurtz's process is one of great importance, especially in view of the immense amounts of money already invested by mining companies in machinery. This process has been successfully tried in stamp batteries, on copper plates, in iron pans and in wooden barrels, and in *every instance* with all the success claimed for it. No feature of the process will commend itself more gratefully to the miner than this; while at the same time the makers of various mechanical amalgamators will perceive that its use will not in the remotest degree conflict with their special forms of machines. Of course some particular modifications of mechanical appliances may be preferred to others, but this is not essential.

The saving of time in amalgamating, and consequently of fuel, power and labor, is another valuable feature of the Company's process, involving, as it does, many collateral advantages. In this way the capacity of the amalgamating machinery may be doubled, and if it be considered desirable to double the capacity of the whole works, the additional outlay would be necessary only for the crushing and grinding machinery. The economical advantages of this fact must be apparent to all.

In this connection it may not be amiss to remark that the Company's process is extremely simple, and that there are no laborious details which require to be taught to operators. Any millman of ordinary intelligence may, in a few hours time acquire a sufficient knowledge of the operations of the process to enable him to use it properly, and to accomplish all the important results sure to accrue from its adoption.

Did time and space permit, a large amount of evidence could be quoted to prove the imperative necessity of an improved amalgamation process. All gold and silver miners are fully aware of the deficiencies which are inherent in the ordinary

modes of using quicksilver, and it is believed that with one accord they will hail the introduction of the Company's process as the desideratum so long needed. During the period since the company became the assignee of Prof. Wurtz's patents, a large number of miners from all the Pacific States and Territories, as well as from the southern gold-bearing States, and also from Central America, Mexico, and South America, have witnessed experiments in our laboratory; and these practical men have expressed but one opinion about the process: namely, that it could not help accomplishing all its inventor predicted during the years of labor and study he expended in developing it.

The following certificates from eminent men of science will be read with interest:

From Dr. John Torrey, *United States Assayer.*

Professor H. Wurtz,

Dear Sir,—I have made experiments relating to your new process of working gold and silver ores, and have satisfied myself as to the following points:

1. Gold and silver in the native state usually resist quicksilver powerfully.

2. Addition of an excessively minute quantity of sodium as proposed by you gives the quicksilver a powerful attraction for such gold and silver.

3. Quicksilver thus prepared has its cohesion for its own substance exalted in an important degree, so that it resists granulation or *flouring*, and when floured the globules unite more readily again. Experiments made upon one of the worst ores, *arsenical pyrites*, have shown me this, as well that such prepared quicksilver has the power of removing gold from arsenical pyrites, *even when dry.*

4. Such quicksilver enfilms iron without penetrating or corroding it; and this property promises to be useful in operations upon gold ores.

5. Your plans are applicable to all ores of gold and silver; to all methods of amalgamation, and to all machines for the purpose.

6. Your methods should save much fine gold which ordinarily escapes amalgamation, and shorten the time necessary for the manipulation of the ores with the quicksilver, and conduce to the saving of the amalgam.

7. Your prepared quicksilver, when used in a sluice, should collect those particles of gold which are so fine as to be swept away by the water over the surface of ordinary quicksilver.

(Signed) John Torrey, *U. S. Assayer.*

New York, February 23, 1865.

Letter from Mr. Carl Schultz, *of the United States Assay Office.*

U. S. Assay Office, March 22d, 1865.

My Dear Sir,—I have investigated with great interest the new and surprising series of phenomena which arise out of your new methods of operating upon gold and silver ores, and give you at your request the following statement of facts and results.

1. Contrary to general belief, these metals are not readily attacked, when in their native state (even when bright and clean), by quicksilver applied to their surfaces: most native gold, on the contrary (as you have observed), showing a *real repulsion* for the fluid metal. Hence the necessity for the mechanical means usually employed for overcoming this repulsion and producing artificial polished or abraded surfaces which can take up the quicksilver.

2. Your very cheap, simple and practical methods of modifying the properties of ordinary quicksilver, and of enhancing its affinities for metals, give us the means of neutralizing this repulsion and converting it into a sensible attraction (almost justifying the term "magnetic"); and will enable us, I am convinced, to accomplish a more thorough saving of gold and silver from the ores with far less labor, time, and expense than heretofore.

3. Your methods, at the same time, accomplish the still more important object of enhancing the attraction of quicksilver *for itself*, thus causing small globules (even enfilmed with foreign matter) when brought in contact, to coalesce instantly, and with considerable energy, into one. This property must be of great value in preventing the great loss both of amalgam and of quicksilver which arises from the "flouring" of ordinary quicksilver, when ground or agitated with the ores.

I have found that fused globules of gold which do not repel ordinary quicksilver like native gold, but become slightly enfilmed at the points of contact, are forcibly sucked in and swallowed up in a moment by your quicksilver. I find fused silver to behave similarly, particularly if enfilmed, as when produced by granulating silver coin.

I have also repeated your recently devised experiments demonstrating the prevention of flouring suggested by the observations of Millon, on the powerful flouring action of saline solutions. Ordinary quicksilver is quickly converted by agitation with a weak solution of sulphate of iron, into a fine flour, the minute detached globules of which coalesce again with exceeding slowness. This accounts fully, as you have suggested, for the injurious flouring action of the sulphurets in the ores, *sulphates* being formed by oxydation. Such a fine quicksilver is almost instantly collected into one homogeneous mass by a small addition of your modified quicksilver, and renewed agitation with the same solution no longer produces any flouring action.

No demonstration of the value of your invention in its application to ores more direct and conclusive than this, could be well devised.

In conclusion, I strongly recommend to all interested in the extraction of gold and silver from their ores, the most thorough trial of your new processes, especially as no essential alterations will be required in the machinery or modes of operation now in use.

Your most ob'd't servant,

(Signed) CARL SCHULTZ, *Assistant Assayer.*

Prof. HENRY WURTZ.

Extracts from a report made by Prof. B. SILLIMAN *to the Montpelier Gold Mining Association, on the Wheeler Gold Veins, Downieville, Sierra County, California, November,* 1865.

* * *

"I had no means of determining the quantity of quartz crushed, nor its average yield. It was asserted, however, that the quantity was about 1500 tons; if so, the average yield was about forty-six dollars per ton. If it proves, on renewed trial, to yield an average of thirty dollars per ton, it will produce splendid results.

"The assay above given would seem to justify a higher average, but it is almost impossible to avoid, in a hand sample, selecting specimens much above the general average. *Improvements in amalgamation are likely, however, greatly to increase the value of all gold mines in California.* Of this more will be said presently. Many mines, which by assay ought to return handsome profits, *owing to imperfect amalgamation* have not proved profitable.

* * *

"The mill should be constructed to amalgamate in battery. It should also be provided with pretty fine screens (No. 6 or No. 7); and *an ample apron of heavy copper plates amalgamated with Sodium Amalgam.*

"The most promising discovery yet made in improved amalgamation is that of employing the *Sodium Amalgam of Mercury,* discovered by Henry Wurtz, Esq., of New York, and now coming to command attention. I have tried experiments in a small way with this amalgam, the results of which are wonderful. This is not the place to describe the process or its mode of manipulation; suffice it to say, no particle of gold escapes amalgamation, if it is brought, even for the briefest period, in contact with Sodium Quicksilver. An exceedingly minute proportion of the Sodium Amalgam suffices to give the "Magnetic Property" to quicksilver, enduing it with the power of seizing the gold with the same avidity that water is soaked up by a sponge. I shall prosecute this subject practically, and, long before the time

you will be called on to use the amalgamation process, I shall be prepared to give advice on it to your mill-man.

"I anticipate from the maturing of this discovery immense advantages to the business of gold amalgamation: indeed, it would not be surprising that in many mines the present product should be doubled. Carefully prepared samples of tailings made by myself from some of the Grass Valley mines showed the quartz tailings to be worth over thirty dollars the ton, a quantity as large as the average yield daily in that locality, and the same which we make the basis of estimates in case of this property."

A short time subsequent to the date of the report from which the above extracts were made, opportunities were presented to try the company's process on a scale of considerable magnitude in a Freiberg pan. The operations were conducted by Prof. Silliman in person, who made it the subject of a paper read by him before the National Academy of Sciences at the meeting held in Washington in January last. The paper, considerably abridged, is herewith annexed as taken from the *National Intelligencer* of January 29th.

On Sodium Amalgamation, with Special Reference to Saving the Precious Metals, and especially Gold; by Professor B. Silliman.

It is well known to metallurgists that the amalgamation of gold is often attended with peculiar difficulties, and that in the best conducted operations on the large scale there is always a considerable, often a large loss, of the precious metal. Samples of waste, or "tailings," collected by myself at various amalgamation works in Grass Valley, California, a place noted above most others for the great success which has attended amalgamation of gold, proved on assay to contain in the quartz waste over thirty dollars to the ton, and in the sulphids over fifty dollars to the ton—showing a loss nearly equal to the average amount saved in that district. One of the most cautious and experienced metallurgists of California, at one time connected with the Geological Commission of that State, informed me that by his own determinations the saving in a large number of cases was barely 30 per cent. of the gross contents of the ore, as shown by careful assays, both of the ore and the waste.

The causes of this large loss are various, among which may be mentioned imperfect processes, insufficient comminution of the ore, and the difficulty of bringing the gold into contact with the mercury. In an ore containing one ounce of gold to the ton of quartz or waste, the ratio is as one to thirty-two thousand (1 to 32,000), or less than one-fourth of one grain in one pound of stuff.

It is, however, well known to all who are conversant with gold amalgamation, that the mercury often appears perfectly in-

different to the gold even when brought in contact with it, failing to amalgamate it. This indifference may be sometimes traced to a minute portion of grease which effectually checks amalgamation, but it is quite as often due to some other and less obvious cause, baffling often the skill of the best amalgamators and resulting in a ruinous loss of the precious metal.

Numerous inventions have been devised to save this loss, and avoid the causes which involve it, but until lately with very indifferent success. One of the most promising, viz., the use of mercurial vapor, has proved itself on trial in the large way a failure, and the problem has remained, in a great measure, unsolved.

Early in 1864 Prof. Henry Wurtz communicated to me in conversation, his conviction, as the result of preliminary experiments, that the use of a minute portion of the metal Sodium would impart to mercury the power of amalgamating with gold readily under any of the adverse conditions which had thus far proved so serious a drawback to the practice of this art. Leaving soon afterwards for California, I have had no opportunity, until within a few months past, of acquainting myself with Mr. Wurtz's plans. Meantime he has secured his invention by letters patent. * * *

EXPERIMENTS UPON GOLD ORES.

Having at my disposal a considerable quantity of California gold quartz from a mine in Calaveras county, I proposed to Mr. Wurtz to subject these ores to his method of amalgamation, under conditions subject to control, both as expressing the actual value of the material experimented on, as well as giving the value of the results and the loss in the process.

FIRST SERIES OF EXPERIMENTS.

One lot of very poor ores, being quartz, showing no gold, but some iron pyrites and much ochrey matter, being crushed and ground, gave of fine dry powder 525 pounds.

Several assays of this lot, made both at the U. S. Assay Office by Dr. Torrey, and also by Dr. Buck, a private assayer of excellent repute, gave an average value to the ore, on the ton of 2,000 pounds—

Gold, - - - - - -	$13.56
Silver, - - - - - - -	1.33
	$14.89

The whole of this lot of 525 lbs., or rather more than a quarter of a ton of pulverized ore, was then treated in a Freiberg amalgamating pan, provided with 16 mullers and driven by steam power. In this apparatus the mass was first made into a thin paste with water, and then treated for one hour with

twenty pounds of mercury, to which four ounces of Mr. W.'s No. 2 sodium amalgam was added in four successive doses, applied at about equal intervals of time during the process, the alloy being dissolved in a small part of the mercury.

On cleaning up the results of the experiment, and obtaining as nearly as possible average samples of the waste, the entire amount of mercury used in the experiment was recovered with a loss of less than one 320th of the original quantity. On careful distillation (retorting) the button of bullion melted at the United States Assay Office gave 0·1925 of one ounce troy of a fineness of 827 thousandths and a value of $3,29.5, or, calculated upon the ton of 2,000 lbs., giving a value per ton of $14,03 of precious metal.

The tailings from this experiment yielded to assay a mere trace of gold too small to be weighed.

The concentrated sulphids washed from the tailings, and representing a very small fraction of the whole original mass, gave as the result of two assays

	$1,183.73
	1,140.63
Average, - -	1,162.18 per ton of 2,000 lbs.

On calculating the ratio of these concentrated tailings to the whole mass it was found to be as 1 to 1700, giving about 70 cents as the bullion value additional to the bullion obtained by amalgamation, giving a total of $14.73, and differing by only 16 cents from the entire chemical contents as shown by the average of several assays.

In other words, the sodium amalgamation had in this experiment saved, practically speaking, *all the gold* in an ore containing less than $15 to the ton.

SECOND SERIES OF EXPERIMENTS.

Another lot of ores from the same mine, known to be much richer than the first, was in like manner ground to a fine powder, and very carefully sampled in a manner to secure a fair average.

Repeated assays, both at the United States Assay Office and at the private office of Partz & Buck, fixed the value of this sample of about 80 pounds of powdered ore at $320 per ton, the range of difference being quite moderate. The assays gave respectively $293.63, $332.78, $296.37, $368.22, $306.20, $320.36, the average result of these being closely $320 per ton of 2,000 lbs. of ore.

In treating this sample a different mode of experimenting was adopted.

A small rotating cask, capable of treating 10 or 15 pounds of ore, was arranged in imitation of the usual Freiberg Barrel. In

operating on small quantities of ore (10 or 15 pounds, for example,) the ratio of loss and error is much higher than in treating larger quantities, as in the great processes of the arts. We did not expect, therefore, to obtain in this series of experiments results as closely approximating the assay as in the first experiment, which was made upon a scale equal to that of the quartz mill.

EXPERIMENTS.

1. To make a comparative experiment, showing the relative saving power of common quicksilver and of the sodium amalgam, 5 lbs. of the ore were treated for thirty minutes with 2 lbs. of common mercury, which gave per ton of 2,000 lbs.

$118.80 or 37.12 per cent of the average.

The tailings of this experiment panned by hand with 1 oz. of magnetic mercury yielded an additional quantity. 67.20 or 21.00 " " "

$186.00 or 58.00 " " "

2. 10 lbs. of the ore were next treated in the same manner with 1 lb. of common mercury 30 minutes, and the tailings panned in like manner with 1 oz. of magnetic quicksilver, giving in all per ton $182.60 or 57.1 per cent.

3. 10 lbs. of the ore with 1 lb. of common quicksilver for 30 minutes yielded $191.80 or 60 per cent.

Tailings treated for 30 minutes with 1 lb. of magnetic quicksilver ($\frac{1}{4}$ oz. No. 2 amalgam) gave in addition, 63.60 or 20 "

Total, - - - - - $255.40 or 80 "

No appreciable loss of mercury.

4. 10 lbs. of the ore treated for 30 minutes with 1 lb. of magnetic quicksilver, ($\frac{1}{4}$ oz. of No. 2 amalgam,) and the tailings, as in No. 2, treated in a pan with 1 oz. magnetic quicksilver, yielded in all $266.40 or 83.3 per cent.

No appreciable loss of mercury.

These experiments are still in progress, but the results show that with unaided mercury the gold saved is less than 60 per cent. of the whole quantity of gold known to be present. In one experiment less than 40 per cent. was saved, while by the aid of the amalgam of sodium the saving is increased to 80 or 83.3 per cent., or an increase of more than 20 per cent., leading to the reasonable expectation that in the large way at least 80 per cent. of the gold present in a given case may be saved, and in many cases, where the gold is coarse and free, that even better results than this may be attained. The first experi-

ment detailed in which a different amalgamating apparatus was used gave results surprisingly close. I do not think the barrel as good a form of apparatus for this description of amalgamation as some one of the numerous forms of pan now in use. It was employed in these experiments simply because it was a convenient means of treating small quantities of ore in making comparative experiments.

Experiments in California, under my direction, have been set on foot upon a scale of magnitude adequate to test the value of this discovery in the metallurgy of gold in a satisfactory manner, the results of which may now be looked for at no distant day.

The action of the sodium in this case appears to be in a manner electrical, by placing the mercury in a highly electro-positive condition toward the electro-negative gold, seeming to give some reason for the term *magnetic amalgam*, adopted by Mr. Wurtz as the trade-mark of the alloy. The quantity of sodium is entirely too small to allow the supposition that it acts by its chemical affinities.

The amalgam of gold or silver is very liable, as every millman knows to his loss, to granulate and disappear from the plates of the battery, or from the rifles, after it has once been formed. If this granulation takes place it is almost impossible, by the existing modes of amalgamation, to recover the minute particles which float off with the currents of water and are lost. The action of the sodium in recovering mercury which has passed into this condition is, perhaps, its most remarkable property. * * *

January 24, 1866.

Following the reading of this paper an interesting discussion was had on the subject, in which Prof. Henry, Dr. Gibbs, Mr. Hilgard, and others took part. The opinion was expressed that it was "one of the most practical and most interesting papers which had ever been brought before the Academy."

Gold and Silver Amalgamation.

At the present meeting of the National Academy of Sciences, the eminent chemist, Professor Silliman, read a paper on a new method of amalgamation of gold and silver ores, which was listened to with great attention by the distinguished members present. We are permitted to present this paper in detail as a matter of general interest. The reader will find it on our first page this morning. Prof. Silliman stated that in the March number of the American Journal of Science, a more detailed statement of Prof. Wurtz's invention would appear.

The National Academy of Sciences, because of its national character as the exponent of the science of the country, has

been selected as the medium for promulgating for the first time, on the part of the inventor, this interesting matter, which it is believed will be found to possess a national importance.

National Intelligencer.

These experiments were afterwards continued in another form by Prof. Silliman, in order to ascertain whether the assays of the tailings after amalgamation would give results concurrent with the above. The following report of Dr. Torrey bears upon this. The proportion of gold extracted is of course found by subtracting $67.83 from $320, giving $252 as the yield in this case, or about 80 per cent. as before. This furnishes confirmatory evidence of the strongest character.

New York, January 28, 1866.

PROF. B. SILLIMAN,

Dear Sir,—We send you the results of our assay of the "tailings" which you transmitted to us. They were marked,

"Tailings from ore of Auction and Texas Lode, assaying gold $320, after amalgamation with sodium quicksilver,

Gold, per ton, - - - - -	$67.83
Silver, - - - - - -	1.45

Yours respectfully, JOHN TORREY & SON.

The experiments on a practical scale in California alluded to by Prof. Silliman were conducted at the Eureka Mills, Grass Valley, under the supervision of Dr. Fisher. Regarding the success attending these working trials, Prof. Silliman writes to Prof. Wurtz, as follows:

"New Haven, Feb. 27, 1866.

"Prof. HENRY WURTZ,

"*Dear Sir*,—I have received advices under date of Jan. 17 and 27, 1866, from Dr. Fisher in Grass Valley, California, the gentleman I requested to put to the test your new methods of amalgamating gold ores with quicksilver containing sodium, and find therein the following passages bearing upon your inventions:

Under date of Jan. 17:—'Upon applying No. 1 amalgam directly to the clean copper plates, they amalgamate easily and retain their coating better than when coated in the ordinary manner. There were cleaned up after six days run, from the plates coated with magnetic quicksilver, 15 dwts. of amalgam, while the five plates coated in the usual manner cleaned up but 13½ dwts. The plates were of the same size, had never been used before, and were coated at the same time. They were placed side by side in two sluices, each fed from the same battery, and in all respects the conditions were made as nearly alike as possible.

'As I advised you in my last, the 'Eureka Mill,' or any other in which the 'blanket process' is employed, cannot give

the sodium amalgam a fair test so far as its value in saving gold on an incline is concerned; for 90 per cent. of the total gold saved is detained by the blankets.' * *

'Parties have been experimenting in Nevada for some time past with sodium. At the Gould & Curry mill, they tried sodium amalgam in the Hepburn pan (1000 lbs. charges of ore) with very satisfactory results. After running six hours at a temperature of 150°, the contents of the pan were run off, and the yield of silver was ten per cent. greater than when operating as usual! Mr. Attwood tells me that his son, amalgamator at the Ophir mill in Virginia City, has obtained still better results with the Freiberg barrel.'" * *

"Under date of Jan. 27, 1866:—' * * It seems to me that the great value of sodium will prove to be in pans and barrels and on copper plates. *Last week, in my experiments at Eureka, the gold amalgam from the plates coated with sodium amalgam weighed seventy per cent more than that from plates coated in the usual way!!*' * * Yours truly,

(Signed) B. Silliman."

Experiments on ore from the "Moss Lode," Arizona.

United States Assay Office, New York, Feb. 28th, 1866.

Prof. Henry Wurtz,

Dear Sir,—We herewith send you the results of our experiments on the comparative value of the new method of amalgamation invented by you, and the old method with ordinary mercury.

Having in our possession a quantity of very rich gold quartz from the *Moss Lode*, *Arizona*, we had it crushed, and the larger lumps and grains of gold separated mechanically. The residue gave us on assay:

Gold per ton (2000 lbs.),	$1072.00
Silver,	30.00
Total,	$1102.00

First experiment.—Eight lbs. of the residue was treated in a small barrel amalgamator with 16 oz. common quicksilver for thirty minutes; then panned carefully by hand, 1 oz. of quicksilver being added during the panning to collect together the pasty amalgam. Sixty minutes was occupied in the panning. The recovered quicksilver, including of course the bullion, weighed 16 oz. 394½ grains. The fused bullion obtained in this experiment weighed 61 $\frac{9}{10}$ grains, and had a fineness of

Gold,	706·5
Silver,	291·0
Base metals,	2·5
	1000·0

This corresponds to a yield of fine gold per ton of $470, or 44·87 per cent of the fire assay.

The loss of quicksilver in this experiment was ¼ oz. (105 grains, to be exact) =1·47 p. c. of the whole amount used.

Second experiment.—Eight lbs. of the residue was treated in the same way, for the same time, with 16¼ oz. of quicksilver containing sodium; then panned by hand for forty minutes, 1 oz. of the same quicksilver being added during the panning. The amount of your No. 2 magnetic amalgam used was ¼ oz. The recovered quicksilver (with the bullion) weighed 17½ oz. The fused bullion obtained weighed 107 4/10 grains, and its assay gave

Gold,	705·0
Silver,	146·0
Base metals,	149·0
	1000·0

This corresponds to a yield *of* $817.50 *per ton, or* 78 *per cent. of the fire assay. There was no loss of quicksilver in this experiment.*

Third experiment.—The tailings from the first experiment were collected as well as possible, and operated on again with "magnetic quicksilver," just as in the second experiment. Thirty minutes was occupied in panning. The result was (without appreciable loss of quicksilver), 19 grains of bullion, assaying

Gold,	716·2
Silver,	283·8
	1000·0

Corresponding to fine gold per ton $134, or 14 per cent. of the fire assay.

These results and not a few others of a similar kind, show conclusively the efficacy of your new mode of amalgamation, and its great superiority over the usual method in which ordinary quicksilver is used.

Yours respectfully,
JOHN TORREY & SON.

I witnessed the experiments recounted above, and take pleasure in adding my opinion that they fully demonstrated the superiority of the sodium amalgamation process.

(Signed) CARL SCHULTZ, *Assistant Assayer.*

U. S. Assay Office, New York, March 9, 1866.

Results with Sodium Amalgam in England and California.

J. Mosheimer writes the following to the San Francisco (California) Mining and Scientific Press: "I am continually receiving letters from the interior, asking questions as to whether

sodium is a benefit to amalgamation or not. My answers are always that it is. It is not my habit to ridicule people for giving their experiments to the public through the press, no matter how insignificant they are; but I suppose every one knows that in so important a question as the use of sodium in amalgamating gold and silver, we cannot take, as a conclusion, an experiment made with a porcelain dish and iron nail. I let every one judge for himself, and only give you my experience, and that which has been directly communicated to me from others. T. A. Readwin wrote to me, about eight months ago, that he is making experiments in North Wales, England, with sodium amalgam. He informs me that he uses small iron pans and my amalgamators; an equal number of pans being worked with and without sodium. The result has been that at least 30 per cent. more gold was produced with sodium than without its use. He has promised to give me further results of his experiments as they transpire, which in due time, Messrs. Editors, I will transmit to you.

"About five months ago I received several lots of ore to work; and I determined to give sodium a fair test. I worked the same ore, side by side, with the same machinery, and the results were as follows: First lot of 500 lbs., each pan with sodium, yielded 85 per cent. of the assay, without sodium the yield was only 55 per cent. Second lot, different ore, with sodium, 80 per cent.; without sodium, 60. Third lot, different ore, with sodium, 78 per cent.; without sodium, 65. I made many more trials, and found that I got from 5 to 25 per cent more by using sodium than I could obtain without its aid. I noticed a very great difference, however, in the different kinds of ores which I worked. For certain classes of ores I believe sodium to be of great benefit; less for others. A fair trial, on a larger scale, would soon settle the question; and I hope some of your correspondents will give the sodium a fair test.

J. MOSHEIMER."

Letter from Prof. Charles A. Seely.

Office and Laboratory, 246 Canal st. New York, March 20th, 1866.

Prof. HENRY WURTZ,

Dear Sir,—I have faithfully used the sodium amalgam furnished by you, in demonstrating its remarkable properties. My experiments fully confirm the statements you have made in the March number of Silliman's Journal.

I have no doubt that sodium amalgam will soon come into general use in the amalgamation of the precious metals, and that it will have a notable effect in increasing the profits of our gold and silver mining companies. Very respectfully yours,

(Signed) CHARLES A. SEELY.

ON

SODIUM AMALGAMATION,

IN A LETTER FROM

HENRY WURTZ TO PROFESSOR B. SILLIMAN.

[From the American Journal of Science and Arts, Vol. XLI, Mar., 1866.]

NEW HAVEN:
PRINTED BY E. HAYES, 426 CHAPEL ST.
1866.

ON SODIUM AMALGAMATION.

In the opinion of yourself and others upon whose judgment I rely, the time has arrived for the promulgation of the discoveries made by me, now many years since, of certain new properties of the alkali-metals, rendering them of value in the amalgamation of ores of the precious metals.

You are aware that, pending the repeated investigations which I have conducted upon this important subject, I have made communications of my results, both oral and written, from time to time to many persons, yourself among the number; but that until the latter part of the year 1864, no final step was taken to place these discoveries before the public in a tangible form. On the 27th of December, 1864, a patent of the U. S. Government was granted to me for specified modes of applying the said discoveries; the specification having been at my request retained on file in the Patent Office for six months (as the new patent law permits); so that the expiration of the term of this patent did not commence until the 27th of June, 1865.

It appears, however, that my frequent communications had led to wide discussion of the remarkable phenomena involved, phenomena which I seldom hesitated to exhibit, even to the most casual acquaintances, taking only the precaution of silence as to the agent employed (the sodium); and the inevitable consequence has been the occupation of other minds with the subject, both here and abroad. In fact, since the issue of my patent, I am informed that several applications (necessarily fruitless) have been made at Washington by others for patents covering some or all of my uses of the alkali-metals; and an English patent has been procured in the name of the eminent chemist Wm. Crookes, dated Aug. 12, 1865 (about eight months subsequent to the filing of my specification at Washington); of the specification of which I have procured a copy, and find it to present a remarkable similarity to my own. Moreover, I frequently find allusions and statements relating to this subject, generally more or less imperfect and obscure, in the public prints throughout the world.

It has clearly, therefore, become incumbent upon me—if only as a matter of justice to the mining community and others interested—to furnish authentic information as to what has

actually been done, and what it is proposed to do. I have, therefore, prepared an abstract of my specification, embodying in a condensed form such portions of its substance as appear of present importance to miners and metallurgists.

Other portions of the subject-matter of the specification will form a sufficiently voluminous, and I hope interesting, topic of a future communication; as, for instance, my new modes of preparing amalgams of the alkali-metals in large masses with any desired rapidity, safety and economy; and which you, with other chemical scientists who have witnessed its operation, deem important in a purely scientific view; as involving novel phenomena, and illustrating molecular laws obscurely seen at present.

With a few explanatory observations, which seem needed, I shall conclude. I have found it necessary, for practical purposes, to prepare three different grades of the sodium amalgams, differing from each other in their proportions of sodium about as the numbers 1, 2 and 3; and which I designate accordingly.

A few lines, also, regarding the term "magnetic amalgams," which not a few will deem fantastic, and as suggesting unauthorized analogies. I hope to show, however, at some other time, that in applying the term I have followed the dictates of reason, and even the direct path of the modern leaders in cosmical dynamics, the apostles of the doctrine of correlation of physical forces; and that the analogical element which I find is that between attractive and repulsive antagonistic force which exerts a *chemical*, or rather an *elementary discrimination* between bodies at *insensible* distances, and the antagonistic force of magnetic attraction and repulsion, which is so eminent an example of a similar elementary discrimination, though at *sensible* distances also. No one (to offer an illustration nearly, though not quite perfect) doubts the intimate relation between radiated and convected heat, although the one propagates itself throughout the universe of space, whilst the other is susceptible only of diffusion throughout insensible distances, from molecule to molecule.

More of this, however, hereafter. The term, from its convenience alone, will doubtless come into extensive use, as a technical term, among those who are most concerned in the utilization of the magnetic amalgams.

39 Nassau St., New York, January 15, 1866.

Specification.

My invention consists: In imparting to quicksilver * a greatly enhanced adhesion, attraction, or affinity for other metals and for its own substance; by adding to it a minute quantity of one of the highly electro-positive metals * sodium, potassium * etc.

My invention * is applicable:

1st. In all arts and operations in which amalgamation by quicksilver can be made available to separate or extract gold, silver or other precious metals from their ores.

* *

3d. In all operations in which amalgamation by quicksilver, in conjunction with reducing metals, such as iron or zinc, can be made available in recovering metals from their soluble or insoluble saline compounds; such as silver from its sulphate, chlorid or hyposulphite; lead from its sulphate or chlorid; gold from its chlorid or other solution.

* *

8th. In the mercurization of metallic surfaces in general; for instance, in the amalgamation of the surfaces of zinc in voltaic batteries; of the surfaces of copper plates, pans, etc., used in the saving of gold from its ores; * *

9th. In the more convenient transportation of quicksilver, by the reduction thereof into solid forms.

* *

I shall now proceed to the description of those special and peculiar qualities of these amalgams of the alkali-metals which I have discovered, and which have led to my new uses of them in the chemical and metallurgic arts.

A quantity of one of the magnetic amalgams, dissolved in one hundred times its weight or more of quicksilver, communicates to the whole a greatly enhanced power of adhering to metals; and particularly to those which, like gold and silver, lie toward the negative end of the electro-chemical scale. This power of adhesion, in the case of these two metals, is so great, that the resistance which I have found their surfaces, when in the native state, usually oppose to amalgamation (a resistance which is much greater and more general than has been hitherto recognized, and which is due to causes as yet undiscovered, or at least uninvestigated) is instantly overcome; whether their particles be coarse, fine, or even impalpable. Even an artificial coating of oil or grease (which is such an enemy to amalgamation that the smoke of the miners' lamps is pronounced highly detrimental in gold and silver mines) forms no obstacle to immediate amalgamation by this magnetic quicksilver. The atoms of the quicksilver are, as it would seem, put into a polaric condition by a minute addition of one of those metals which range themselves toward the electro-positive end of the scale; so that its affinity for the more electro-negative metals is so greatly exalted that it seizes upon, and is absorbed by, their surfaces instantaneously; just as water is absorbed by a lump of sugar or other porous substance soluble in it.

Such quicksilver (unlike ordinary quicksilver) even adheres strongly to surfaces of iron, steel, platinum, aluminum and antimony; an adhesion which, however, as I have discovered, in the case of these five metals is not of the nature of a true amalgamation, there being no penetration whatever into the substance of the metal; so that the superficially adherent magnetic quicksilver may be readily wiped off clean, just as water may be from glass. The only metal I have as yet found, which cannot be enfilmed by the use of the magnetic amalgam, is magnesium.

I shall now specify the details of my various new and useful applications of the alkali-metals:

I. *Applications of the magnetic amalgams to working the ores of the precious metals.*

My improvement in methods of amalgamating gold and silver ores consists in adding from time to time to the quicksilver used in amalgamation, about one-hundredth part, or less, of its weight of one of the magnetic amalgams. The frequency with which the amalgam is to be added cannot be exactly specified, as it will be found to depend more or less on a multitude of circumstances; such, for instance, as the temperature, the purity of the water and the quantity of water used, the ratio borne by the surface of the quicksilver to its mass, the amount and mode of agitation of the quicksilver, the nature of the process and of the apparatus used, the character of the ore, the strength of the amalgam, etc., etc.; so that this important point can only be determined by experience in each case. Some general directions may, however, be derived from the experiments which have been made. It has been found that very much less sodium is requisite in those cases in which much water is employed, and that water frequently renewed; for instance, in the "riffles" of a sluice, and in all forms of amalgamators through which a continual current of fresh water is kept running; mercurial solutions of sodium, as I have discovered, being little affected by water which is free from acid, alkaline, or saline impurities. In those cases, however, in which little water is employed, and especially when the ore and quicksilver are ground up together into a "slum" or slime, this water soon becomes alkaline, and an oxydation of the sodium sets in, necessitating its frequent renewal. In such cases, therefore, the following manipulation is recommended: The whole amount of quicksilver to be used for working up a batch of slime, say 50 pounds, is magnetized by dissolving in it one per cent of amalgam No. 2; or better, two per cent of the soft amalgam No. 1, which dissolves more readily; half of the whole, or 25 pounds, is then thrown into

the mill with the ore at first, and, as the incorporation proceeds, certain fractions of the other half are gradually added, at intervals of time varying according to circumstances, until the whole has been added. If, as is usual, the quicksilver is a portion which has been separated from the slime of a previous operation, it will usually retain some sodium, and therefore will require fresh amalgam in proportionately smaller quantity.

In sluicing operations the soft amalgam No. 1 is most suitable, on account of its ready solubility in mercury; and in these cases it is practicable to *test* the quicksilver in the "riffles" and ascertain when the magnetic quality requires restoration, by throwing in a few grains of gold-dust. Similar tests are easily applied to slimes, and in amalgamating methods generally, a slip of tarnished sheet copper being a very suitable agent for such testings.

It may be remarked in passing, that the amalgam No. 1 is at any time easily prepared from No. 2, by melting it in an iron ladle with about its own weight of quicksilver, or from No. 3, by melting with twice its weight; considerable time, however, being requisite, in the case of No. 3, to produce the additional combination. In copper-plate amalgamation, that is, in those cases in which auriferous materials are brought into contact with amalgamated metallic surfaces, it is better to substitute altogether for quicksilver itself (both in the first coating of the metallic surfaces, and in any subsequent additions of quicksilver made) the pasty amalgam No. 1. In these modes of amalgamation great economy in wear and tear of apparatus, as well as in first cost, is effected by using, in connection with the magnetic amalgam, plates or surfaces of *iron* instead of copper. The power of coating or enfilming iron renders the amalgams in fact peculiarly valuable in every form of arrastra, drag-mill, or other apparatus for amalgamation which has internal surfaces of iron, these surfaces becoming coated over with quicksilver, and thus immensely extending its chances of contact with those particles of gold which are so fine as to remain suspended in the water.

Other important devices arise out of this power of enfilming iron surfaces, such as the keeping of iron surfaces of stamps, and of other apparatus used in *crushing* ores continually coated with quicksilver. Quicksilver possessed of the magnetic quality may be kept dropping or trickling upon the surfaces of crushing-rollers; or in those crushers in which iron balls are used, the surfaces of these balls may be kept enfilmed. In like manner as the *adhesion* of quicksilver to other metals is exalted by the alkali-metals, so, also, as I have discovered, is its *cohesion* with itself greatly increased. It is rendered more viscid, more difficult to divide mechanically, and when thus divided runs together again instantly upon contact. Hence arise new results

of incalculable value. For instance, the so-called "flouring" or granulation of the quicksilver, which in the amalgamation of ores always occasions so great losses, both of the quicksilver itself and of its amalgams with the precious metals, is reduced to a *minimum* or altogether prevented.

The recovery of floured quicksilver and amalgams from slimes and similar mixtures is also greatly facilitated and accelerated thereby. For this purpose some strongly magnetized quicksilver is thrown into the separator. Such slimes may even be operated upon with advantage by the ordinary process of *panning by hand;* a little magnetic quicksilver being thrown into each pan and stirred about at first for a few moments with the hand, which will collect together and incorporate all the scattered globules of auriferous amalgam. In fact, in all panning operations, even upon the pay-dirt of placer diggings, much labor, gold, and time may in this way be saved.

It is necessary to specify an important precaution applicable in some cases in which magnetic amalgams are used, and particularly in those cases in which the ore is ground or agitated with quicksilver in contact with metallic iron. This arises from the liability of the adhesion of some abraded particles of iron to the amalgam. The following plan is therefore recommended in these cases: The amalgam, after separation from the excess of quicksilver, and before retorting, is fused in an earthen dish or iron ladle (with addition of a little quicksilver, if necessary, to make it more fluid), and the iron, which will rise and form a scum on the surface, is skimmed off. The excess of quicksilver may then, after cooling, be again separated from the amalgam in the usual way. Any amalgam which may adhere to the iron-scum is readily detached therefrom by boiling in water to remove the sodium. This process depends on the simple fact that the adhesion to the iron totally disappears with the extraction of the last traces of sodium from the quicksilver. In fact, it is possible to remove all the iron from the amalgam by boiling directly in water, without any previous fusion; more particularly if the water be made somewhat acid or alkaline. The presence of iron in a sample of amalgam is readily detected by the magnet, which instrument may be sometimes used to advantage also in separating intermixed iron from amalgam, after all sodium has been extracted from the latter. There are still other metals which will usually be found adherent to the amalgam when sodium has been used; such as platinum and osmiridium. These, like iron, immediately detach themselves on the removal of the sodium by boiling the diluted amalgam in water. A mixture of platinum or osmiridium, or both, with iron, may of course be freed from the latter by the magnet. It will generally be found desirable, as in other cases where quick-

silver is used and ores containing arsenic or sulphur operated upon, to remove as much as practicable of the arsenic or sulphur by previous roasting or other chemical treatment.

* *

III.—*Applications to the recovery of metals from their saline compounds.*

In the common operation of reducing silver to an amalgam from its native or artificial chlorid, or from its sulphate, by the action of metallic iron or zinc in conjunction with quicksilver, immense advantage arises from the use of the magnetic amalgams, especially in the reduction of the time occupied to a fraction of that heretofore required. This applies as well to ores in which the silver occurs naturally as chlorid, bromid or iodid, as to those in which the silver has been previously converted into chlorid, or sulphate, or both, by roasting with common salt or otherwise; and to chlorid which has been precipitated from solution. * * *

When gold has been obtained in solution, either from ores or from other materials, by the action of chlorine, aqua-regia, cyanid of potassium, or any other solvent, also when silver has been obtained in solution, in hyposulphites or otherwise, the most rapid and thorough mode of saving these metals will be found to be their conversion into amalgams, by precipitation with metallic iron in contact with magnetic quicksilver, more especially when the solutions are dilute. * * *

The greater rapidity and perfection of the precipitation, in these cases, are obviously due to the absolute contact at once established with the iron surfaces by the magnetic quicksilver, and the perfect and powerful voltaic circuits thus kept up constantly throughout the two metals and the solution.

* *

VIII.—*Applications to the Mercurializing of Metallic Surfaces in general.*

In all cases in which it is an object to save time and labor in the coating of surfaces of other metals with quicksilver, * * * the magnetic amalgams come into play; * * *

By virtue of the adhesion to iron and other non-amalgamable metals imparted by the magnetic amalgams, I am enabled to apply quicksilver, or fluid or pasty amalgams, to any metallic surface, with great rapidity and facicity, *with a brush*, after the fashion of a paint; the material of such brush being fine wire of iron, steel, alnminum, or platinum. Of these the material most generally suitable is the finest steel wire, tempered to about a spring-temper, or somewhat softer; and the most generally useful form of such brushes, is that of a *flat* varnish or white-wash brush.

Among the important uses of such brushes may be instanced:

the amalgamation of copper (or iron) plates used in saving gold from ores; * * *. Another valuable use is the recovery of quicksilver which has been spilled or scattered in the form of globules; such a flat brush, saturated with magnetic quicksilver, instantly collecting, incorporating, and sucking up the scattered globules, even from the most irregular surface.

The same principle of adhesion of magnetic amalgams to a brush of steel wire, is applicable, in many obvious ways, to the separation of metals from ores, and of granulated or floured quicksilver from ores and slimes, etc.

* *

IX.—*Applications to the Transportation of Quicksilver.*

The ordinary mode of packing and transporting quicksilver in bulk, is very expensive and troublesome; and in its ordinary form its transfer from one vessel into another is accompanied by great liability to loss. It will therefore be found very convenient and useful to possess simple, cheap and practicable modes, such as those described above, of converting it into solid forms, susceptible of transportation in vessels of lighter and cheaper material than the ordinary wrought-iron bottles; such, for instance, as glass or earthen ware jars, wooden kegs, bags or bottles, or other envelops of caoutchouc or gutta-percha, etc., etc.

This plan also enables quicksilver to be packed, stored, transported and sold in convenient forms; such as bars, ingots, cylinders, blocks, cubes, spheres, or pellets, of definite sizes and weights, the convenience of which for many uses, and particularly for that of miners, is at once obvious. When the quicksilver is to be used in any of the arts above specified, it will then be already in a suitable condition, or will merely require admixture with some fluid quicksilver; and when to be used as pure quicksilver, the sodium may be removed by throwing the solid amalgam in fragments into hot water, preferably mixed with a little sulphuric or acetic acid.

The modes of packing such ingots, for preservation and transportation, are already sufficiently set forth in a preceding paragraph.

Claims.—The claims attached to this specification are twenty-three in number; and those only are here given which directly concern the miner and amalgamator.

What I claim as my inventions are:—

1st. The combination with quicksilver, when used for the extraction by amalgamation of any metal or metals from ores, slimes, and mixtures with other materials; of metallic sodium, or metallic potassium, or any other highly electro-positive metal equivalent in its action thereto; as above set forth.

2d. In those amalgamators in which amalgamated plates of copper or other metal are used; the substitution therefor of plates or surfaces of iron, coated with quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

3d. The coating of iron surfaces, between or under which ores or other materials are crushed, with quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

4th. The prevention of the granulation or flouring of quicksilver, when used in any method of amalgamating ores or other materials; by addition thereto of sodium, or other highly electro-positive metal; as above set forth.

5th. The separation of intermixed iron from double amalgams of gold and sodium, or of silver and sodium; by fusion with excess of quicksilver and skimming; as above set forth.

6th. The separation of intermixed iron, platinum, osmiridium, and other non-amalgamable metals, from amalgams containing sodium or its equivalent; by action thereupon of water or other oxydating liquid; as above set forth.

7th. The separation of intermixed iron from amalgams containing sodium or its equivalent, or from any metal or metals extracted from such amalgams; by magnets, either permanent or electro-magnetic; as above set forth.

8th. The combination with quicksilver, when used in conjunction with iron or other reducing metals, for reducing to an amalgam, silver from its chlorid or other compound, or any other metal from any saline compound or solution; of sodium, or other highly electro-positive metal; as above set forth.

* *

12th. In all cases in which metallic surfaces, such as copper plates, the zincs of voltaic batteries, etc., are to be amalgamated; the use of quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

13th. The more rapid and convenient application of quicksilver to surfaces with metallic brushes; by virtue of its previous combination with sodium, or other highly electro-positive metal; as above set forth.

14th. The use of metallic brushes, enfilmed with an amalgam of sodium or its equivalent; for incorporating together particles of quicksilver, gold, silver, or any other metal, scattered throughout ores, slimes, or any other materials; as above set forth.

15th. The more convenient transportation, handling and subdivision of quicksilver; by conversion into solid forms; in the manner herein substantially described.

* *

Editorial Note.—At the session of the National Academy of Sciences held in Washington in January last, Prof. Silliman read a paper upon the sodium amalgamation, detailing the results of a series of experiments conducted by him upon a scale of sufficient magnitude to test the value of this discovery upon gold quartz. In one experiment made on over 500 pounds of low grade ores, worth about $15 per ton, the sodium amalgam extracted practically all the gold not existing in the sulphids. This experiment was conducted in a large-sized Freiberg amalgamator and was continued through one hour, the sodium amalgam being added in four successive portions of one ounce each, dissolved in a portion of the 20 pounds of mercury employed. The loss in mercury was about one ounce in this experiment, the quantity of the sodium amalgam being 1·2 per cent of the total quantity of mercury in use.

In a second series of experiments conducted on carefully prepared samples of richer ore, worth $320 per ton, treated in a revolving barrel, the saving by ordinary mercury was from 40 to 60 per cent of the total quantity of gold present. With the aid of sodium amalgam 83·3 per cent were recovered. The results in the large way in actual practice would probably be more satisfactory than those last named. Prof. S. stated that experiments had also been set on foot in California to test this process on a large scale in the actual working of quartz mills. The results of these experiments will be noticed hereafter.